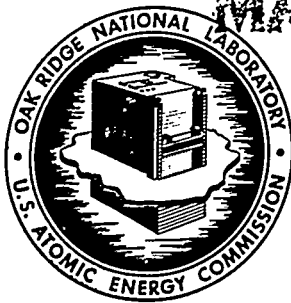


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## OAK RIDGE NATIONAL LABORATORY

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SUBJECT: Accidental Contamination Release in Building 4507 Penthouse

TO: Distribution

FROM: J. H. Goode and V. C. A. Vaughen

## Distribution

1. [REDACTED]
2. [REDACTED]
3. [REDACTED]
4. [REDACTED]
5. [REDACTED]
6. [REDACTED]
7. [REDACTED]

8. [REDACTED]
9. [REDACTED]
10. [REDACTED]
11. [REDACTED]
12. [REDACTED]
13. [REDACTED]
14. [REDACTED]
15. [REDACTED]
16. [REDACTED]

This document has been approved for release  
to the public by:

*David C. Harris* 5/28/96  
Technical Information Officer Data  
ORNL Site

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ChemRisk Document No. 2856



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### I. Building Description

Building 4507 is fully described in the current operating manual and hazards evaluation, ORNL-CF-73-9-4.<sup>1</sup> In brief, Bldg. 4507 consists of four hot cells surrounded on the south side by the operating room where master-slave manipulators service the cells, on the north side by a charging area and a chemical makeup area, and on top by a penthouse. Normal input/output of cell materials is performed through the cell roof to the penthouse containment area.

### II. Penthouse Description and Sketch

The penthouse is a metal-siding building of about 19,463 ft<sup>3</sup> volume above the reinforced concrete cell block. It contains (Fig. 1) a steel-shielded alpha box above cell 1 (east), a steel cover plate over cell 2, and a series of four glove boxes above cells 3 and 4 (west). The penthouse is normally ventilated by the partially-dampened cell ventilation duct (about 1100 to 1200 cfm) in the SW corner and by a filtered (roughing and HEPA) exhaust blower on the north wall. Air inlets are filtered dampers high on the north and south walls. Radiation and contamination monitors (neutron, beta-gamma, and alpha) belonging to the automatic containment and evacuation alarm system are located in the penthouse. Operation of the system which puts the building into containment automatically closes the air inlets, stops the ventilating fan, and fully opens the cell ventilation duct to provide emergency exhausting. The penthouse is maintained about -0.3-in. water relative to the outside environment; the glove box is maintained about -1.25-in. water relative to the penthouse.

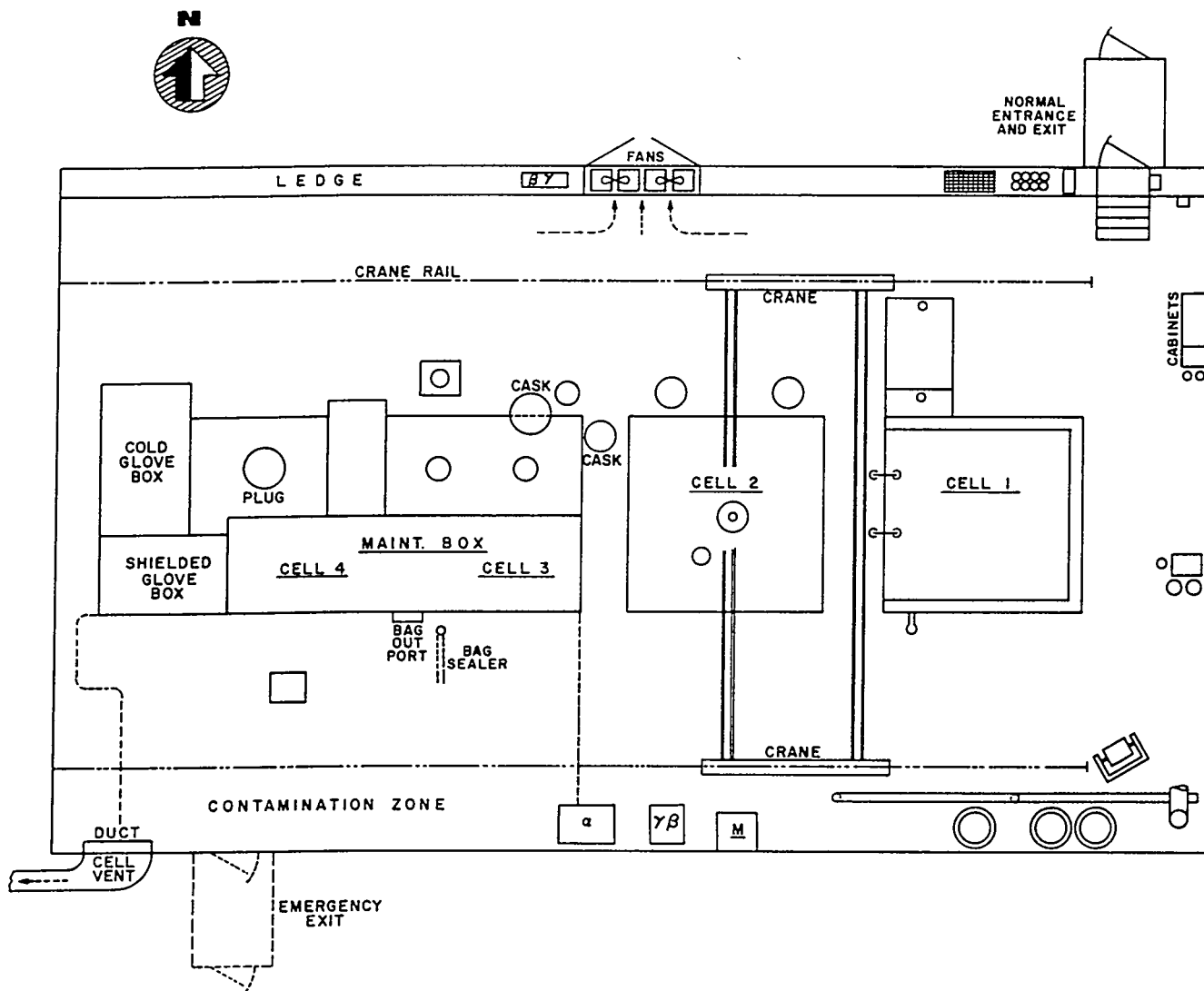
### III. Building Staff

Group leader - [REDACTED]

Building supervisor - [REDACTED]

Cell 1 supervisor - [REDACTED]

Cell 2 supervisor - [REDACTED]



4507 PENTHOUSE

Fig. 1. Building 4507 Penthouse Arrangement.

Technicians

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

\*Present in building at the time.

## IV. Staff Experience

Name	Date of Start of Company Service	Date of Start of 4507 Service	Background
[REDACTED]	1960	1962	Hot cell and glove box work with curium, LMFBR and HTGR fuels.
[REDACTED]	1948	1957	Hot cell and glove box work with PRFR, Pu-Al, LMFBR and HTGR fuels.
[REDACTED]	1963	1970	Hot cell and glove box work with LMFBR and HTGR fuels.
[REDACTED]	1951	1962, 1974	Metal recovery plant, 3019 Pilot Plant, Pu-Al separation at 4507, $^{233}\text{UO}_2$ facility.
[REDACTED]	1953	1966	Hot cell and glove box work with LMFBR and HTGR fuels.
[REDACTED]	1974	1974	Hot cell work with HTGR fuels.
[REDACTED]	1947	1964	4500N Area HP Supervisor

## V. Operations in Progress

During the period of October 1 to 11, [REDACTED] and [REDACTED] were engaged in the removal of miscellaneous small items from cell 4, Bldg. 4507, the first phase of a routine operation leading to the eventual removal of the process equipment and tanks from cells 3 and 4, the Curium Recovery Facility. These cells are scheduled for cleanout and decontamination in order to install other projects in late FY-1975. Remote measurements by [REDACTED] indicated the highest beta-gamma level in cell 4 was about 500 mR/hr. Tools, glass and metal vessels, a muffle furnace, a PVC in-line filter, etc. were pulled from cell 4 into the large glove box atop the cells, and placed into 4 mil-thick polyethylene bags made of 12-in.-diameter bagport tubing. These bags were to be removed from the glove box by standard techniques, sealed into an outer bag, and placed into metal drums for storage at the ORNL Solid Waste Facility.

## VI. The Occurrence

The following sequence of events was reconstructed from conversations with the four participants. On October 14, [REDACTED] and [REDACTED] asked [REDACTED] to assist them in removing about five bags of trash that had been accumulated in the glove box. [REDACTED], the 4507 Health Physics surveyor accompanied the Chemical Technology personnel to the penthouse to monitor the operation as per regulations. Each man wore his film badge and pocket meters, one or two carried dosimeters and one of the audible beta-gamma personal radiation monitors - "chirpers," and C-zone clothing.

At the time of the incident, 3/4 of the penthouse area of 4507 was a regulated zone, free of contamination, in which shoe covers or contamination clothing are not required. A contamination zone had been established south of the cell 3-4 glove box by chains and signs for the removal of the contaminated equipment (Fig. 1). Blotter paper covered the floor north of the gantry crane track for the length of the glove box. Portable alpha monitors were located at the C-zone boundary on the south wall at the east end of the glove box, along with hot cans, extra shoe covers, etc. A beta-gamma CAM and a continuous alpha air monitor (CAAM), which were part of the 4507

emergency containment and evacuation system, were also located along the south wall of the building about 4-5 feet from where the men were working.

Just before 1030 hours on October 14, [REDACTED] had gone to the east end of the penthouse to answer the telephone while [REDACTED] and [REDACTED] selected one of the several bags of stored trash for removal through the 12-in.-dia bag-port on the south face of the glove box. (The electronic heat-sealer for the bags is located on a swing-out pedestal in front of the port.) [REDACTED] stood by [REDACTED] and [REDACTED] with a beta-gamma Cutie Pie and one of the portable alpha monitors. When the bag of trash was put into the bag on the bag-port, [REDACTED] found the material measured about 800 mR/hr beta-gamma at about 2 in. instead of the 100-200 mR/hr found on bags of trash removed the previous week. (The maximum reading was later measured to be about 20 mR/hr at 2 in. after the bag was placed in a stainless steel drum.) We have assumed that no external alpha contamination was found by [REDACTED] at this time, otherwise the operation would have been stopped and the bag put back into the glove box.

The heat-sealer had been tested just prior to the removal operation and found operable. [REDACTED] and [REDACTED], however, could not smooth out the polyethylene of the bag of trash sufficiently to make an adequate seal with the heat-sealer, so in view of the 800 mR/hr radiation field, a field decision was made to use the alternate accepted method of bag separation: taping and cutting. [In this procedure, the polyethylene bagging between the material to be removed and the glove box is gathered and tightly wrapped with 2-in.-wide masking tape to constrain it, and then the bag is severed by cutting through the tape and compacted folds of polyethylene with a knife or scissors. Tape is then placed over both of the severed ends to further seal the bags.]

After making the decision, one of the technicians, probably [REDACTED], standing SW of the bag-port, twisted the bag tightly and held it suspended. [REDACTED] returned from the telephone to just outside the chain boundary, where he tore off a secondary containment bag from the roll of bags on the south leg of the gantry crane. [REDACTED]



standing SE of the bag-port, applied the tape around the twist. As [REDACTED] held his portable alpha monitor over the twisted-and-taped neck of the bag, [REDACTED] cut through the tape with scissors, and placed tape over the end of the twist.

[REDACTED] claimed he heard the portable alpha monitor click and jam as the cut was made; he asked [REDACTED] to move the probe back and it began to click rapidly. At about the same instant the alpha air monitor near the men buzzed as the caution level was passed, and almost immediately reached the high level alarm point. This automatically put the building into containment, sounded the nitrogen-powered evacuation horns, signalled a radiation event at Guard Headquarters, and summoned the ORNL emergency crew.

In the penthouse, the four men took immediate ~~evacive~~ action to leave the contaminated area by the nearest exit without crossing the contaminated source. [REDACTED] left the east boundary of the C-zone, went across the top of cell 2, north of the cell 1 cave, out the regular entrance-exit door in the NE corner, down the outside stairs to the ground, and ran around the outside of 4507 to the east entrance to the operating area. [REDACTED] laid the severed bag of trash onto the blotter paper on the electrical junction box in front of the west end of the glove box, removed his outer gloves, and went out the emergency exit directly in front (south) of the glove box. He stopped on the wooden catwalk on the south roof to remove his shoe covers, coveralls, and inner gloves; then he went down the emergency escape ladder on the outside south wall of the building, and came into the operating area via the east entrance. [REDACTED] removed his shoe covers at the C-zone boundary, went south of the cell 1 cave, and out the NE door of the penthouse. [REDACTED] laid down the scissors, removed his shoe covers, and followed the same escape route. Both men covered their ears with their hands as they passed the evacuation horns, and probably contaminated their hair at this time. Both men went partway down the outside stairs, entered the second floor makeup area doors, passed through it, down the inside stairs to the charging area, and into the change room, where they met [REDACTED] and [REDACTED].

██████████ shoe soles were apparently the only thing contaminated on him. The other three men were contaminated with alpha activity, and proceeded to strip off and bag their contaminated clothing and shoes, and to decontaminate themselves with soap and water in the change room shower.

#### VII. Immediate Follow-up Activities

██████████, in his office in 4500N, heard the horns and saw the flashing lights, attempted to reach ██████████ by phone buzzer to inform him of the event, failed, and went to 4507 to check on the alarm. He entered the control room and went to the containment panel board. His inspection verified that the building was in containment due to alpha contamination in the penthouse. The air horns were still blasting. ██████████ ran in the control room east entrance, came to the panelboard and attempted to reset the buzzers and take the building out of containment. The alarms would not reset. ██████████ entered the control room through the east door and checked himself on the survey meters. He was alpha-contaminated. ██████████ then checked himself and, to his surprise, found he had contamination on his shoes. (He had been away from the active zone.) Two others, ██████████ and ██████████, entered the change room from the rear areas and began to survey and strip down. ██████████ shut off the N<sub>2</sub> supply to the air horns to cut down the noise level. ██████████ finished acknowledging alarms and then ascertained by talking to the men that a bagout had been in progress and activity released. Showering was started.

██████████ broke open emergency cabinet to provide initial supplies. The Lab Shift Supervisor and staff arrived shortly after the alarm was sounded. ██████████ and ██████████ were notified by ██████████ about 10:45.

At about 11:15 AM ██████████ returned to Bldg. 4500 from the 2026 lab and was notified of the incident by ██████████ of Health Physics. He found ██████████ - HP, and ██████████, Shift Supervisor, in 4507 supervising decontamination of the men. ██████████ and ██████████ summoned extra HP surveyors, who surveyed the interior and exterior of 4507 to locate the particulate alpha-emitting contamination

(the penthouse was not entered). The contaminated areas were marked off and decontamination and/or fixation procedures instituted immediately to prevent further spread of the contamination.

Excellent assistance was rendered by all concerned: HP, Laboratory Shift Supervisor, and emergency staff.

After decontaminating the other areas of the building on October 14 and 15, the penthouse was entered on October 16, 1974 by [REDACTED], [REDACTED], and [REDACTED] (HP) for an initial survey. Particulate alpha contamination was found on horizontal surfaces (Fig. 2). Using the alpha probe data and the floor areas on Fig. 2 as the basis of an estimate of the total amount of  $^{244}\text{Cm}$  involved in the spill, we have calculated that about 30-50 micrograms of  $^{244}\text{Cm}$  had been released as a dust. Residual air activity was low\* since the outer clothing did not become contaminated without direct contact. Cleanup was conducted cautiously with a damp-wipe technique. Figures 3-6 are photographs of the penthouse taken on October 16, 1974 showing the accident scene and surroundings.

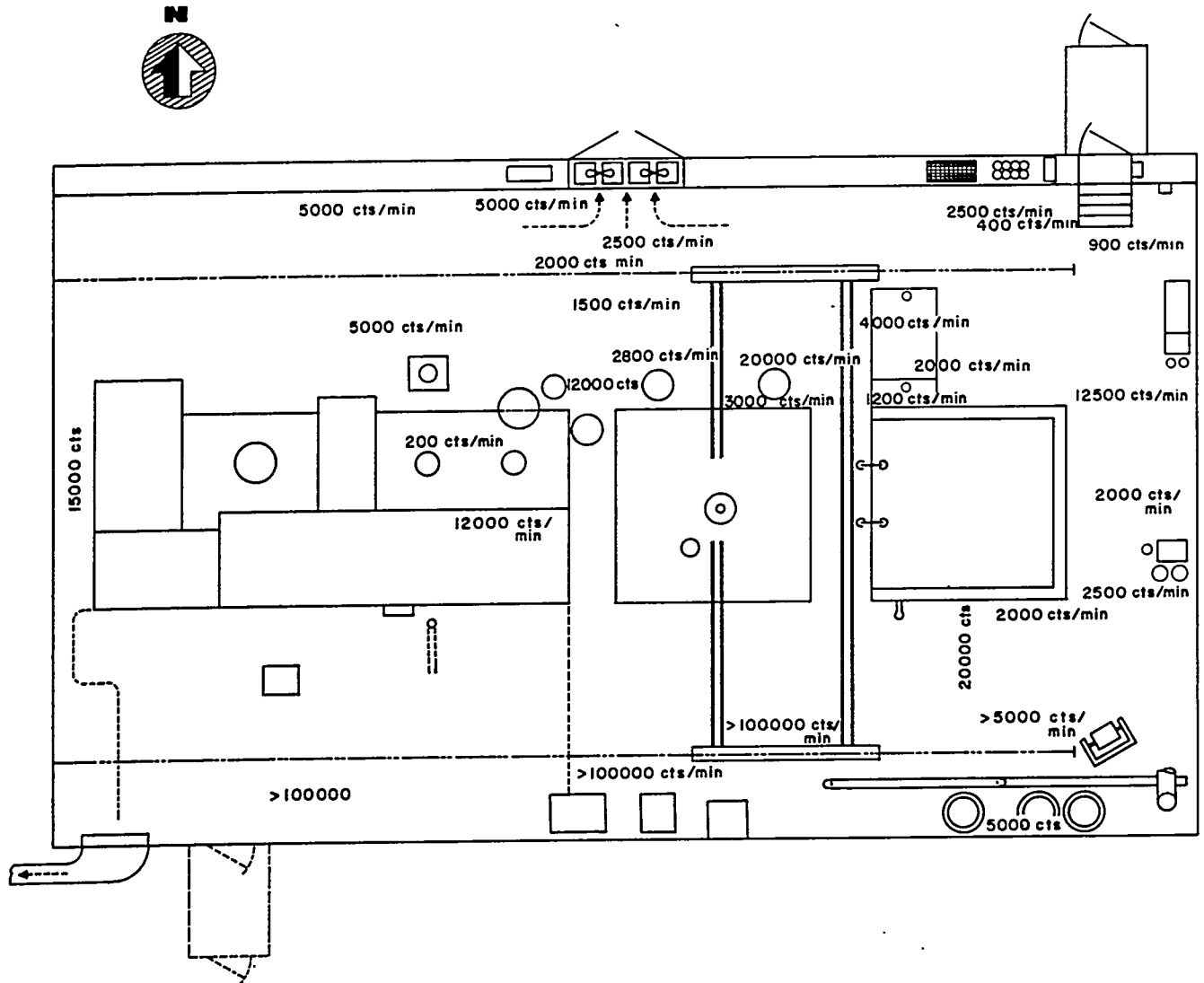
#### VIII. Post-Mortem of the Accident

The three technicians and the HP surveyor were acting within the encouraged area of discretion when they decided to proceed to the alternate method of bagout, after having attempted to use the sealer. We have selected high caliber individuals because we need them in this line of work, and we expect them to make such decisions. Their actions following the evacuation alarm were within the proscribed accepted procedures, with two exceptions:

1. The procedures specify that the personnel wait in the vestibules until HP surveillance can be performed to prevent release of contamination outside the building. This procedure will need to be redone. The vestibules are poorly ventilated and very small. We believe that the protection of individuals should come first and the prompt action to get to the showers was a far superior solution to waiting in the vestibule. Had the team been in gas masks at the time of the accident, waiting in the vestibules would have been merely uncomfortable, not definitely hazardous.

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\*Less than 5 dpm on a 5 min-45 cfm air sample with Hi-Vol sampler at the penthouse entrance.



4507 PENTHOUSE

Fig. 2. Alpha Probe Readings Two Days After Spill.

PHOTO 3082-74

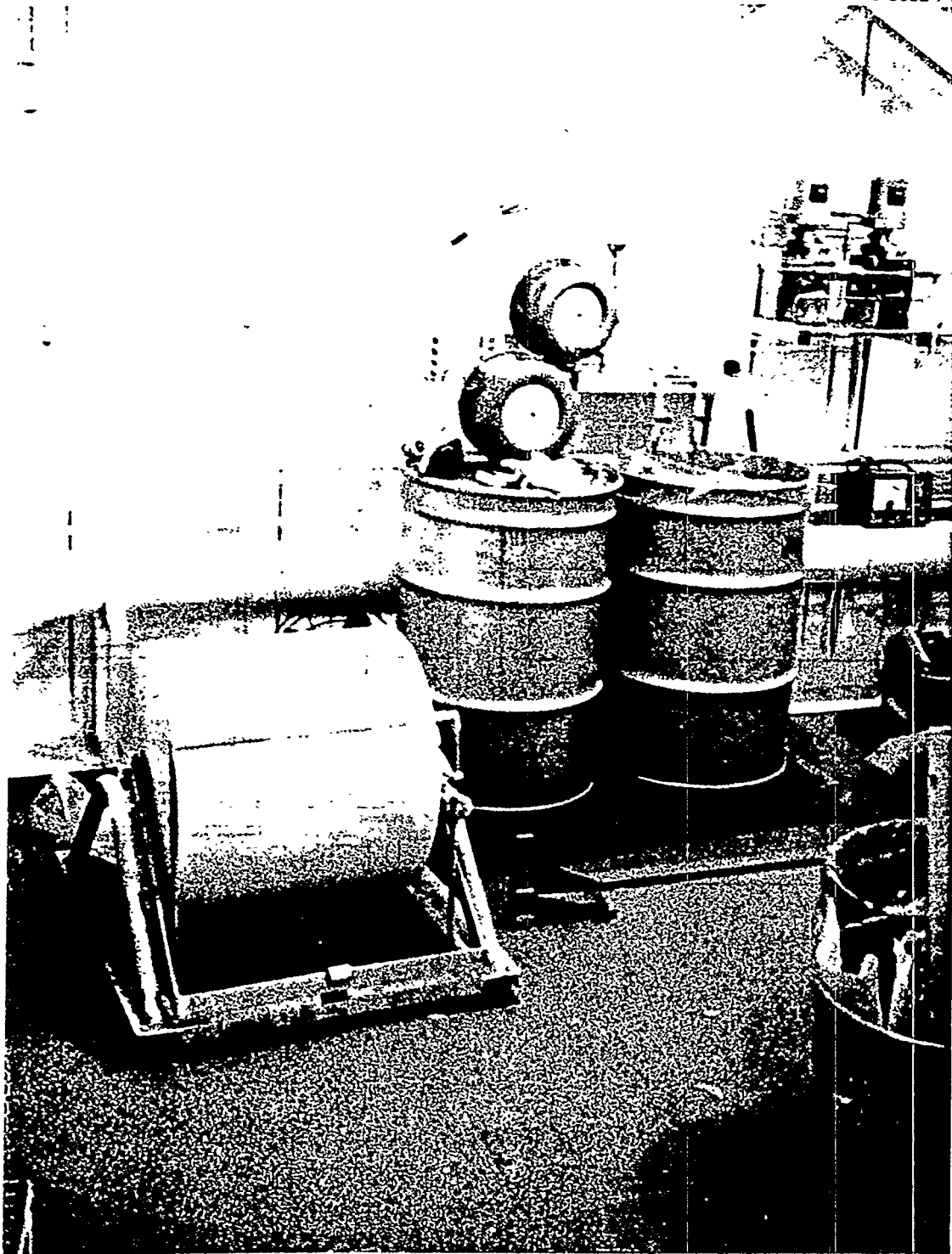


Fig. 3. Looking South from Entrance Vestibule.

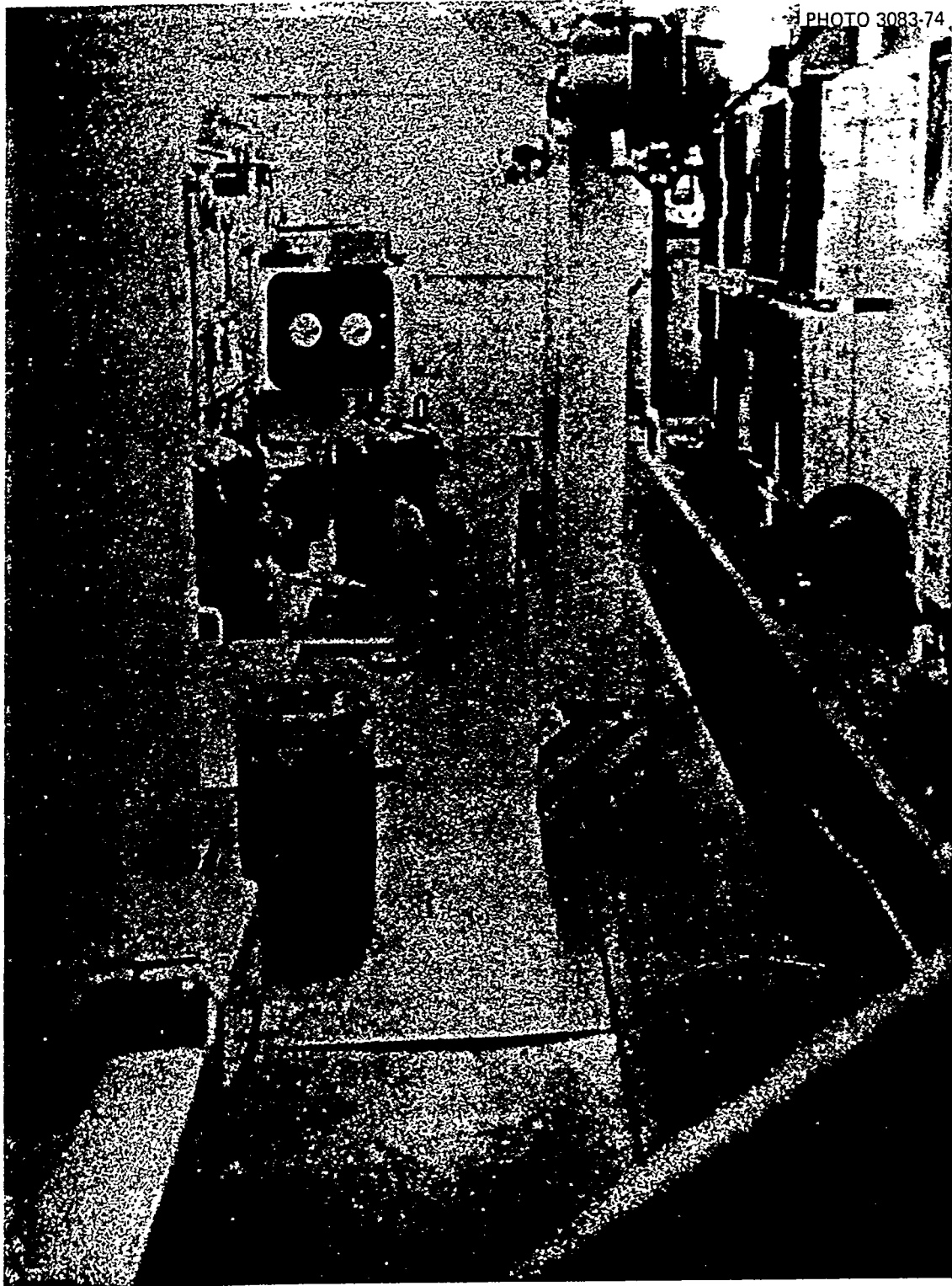


Fig. 4. North Side, Looking West. Note gantry crane, filters, casks.

PHOTO 3084-74



Fig. 5. South Side, Looking West. Note crane, air monitors, C-zone.

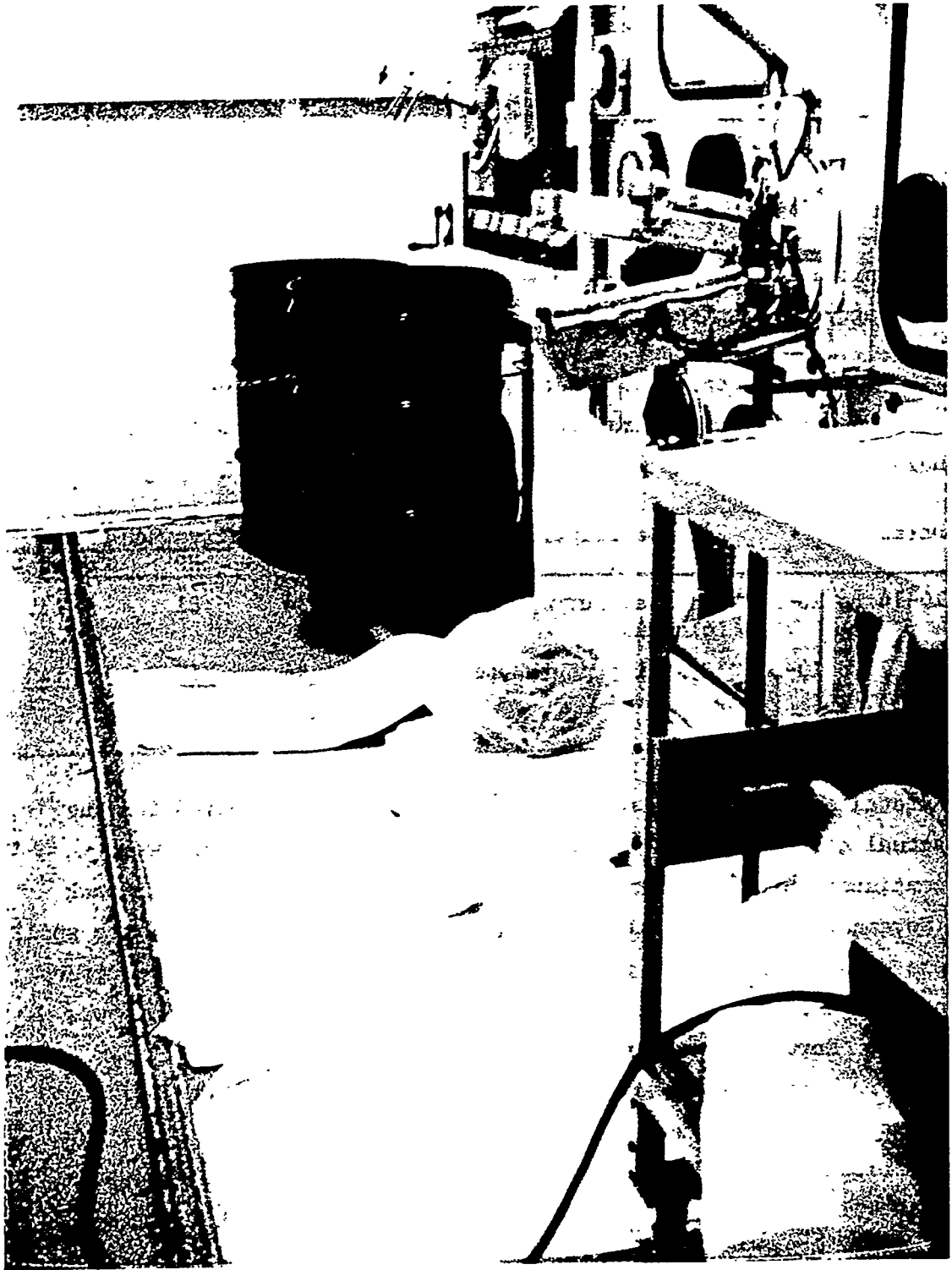


Fig. 6. Spill Area. Note bag, bag sealer, bag-out port, chain.



2. One technician left the penthouse north exit and descended to the ground going around the building when he should have re-entered the second level. He is a recent transferee to the building and this indicates that he was not adequately trained in the Bldg. 4507 practices and procedures to respond properly in an emergency.

In our opinion, the contamination was released and made airborne most probably by trapping and compressing air in the bag during the bagout operation, which was released on cutting the taped section.

#### IX. Impact of Occurrence on Programs

The manpower required for the cleanup of Bldg. 4507 is summarized below:

Dates	Description	Active Man-Hours		
		CTD	HP	Total
10-14 to 10-16	Initial surveys and cleaning	54	81	135
10-17 to 10-31	Cleaning penthouse	<u>84</u>	<u>56</u>	<u>140</u>
	Total	138	137	275

A total of about three weeks of elapsed time was required for the actual cleaning in 4507; calculations and other desk work were continued part time during the same period. During a fourth week (November 4-8, 1974), the bag sealer located at the site of the spill was decontaminated for use, the roof fans tested, and daily surveys of the penthouse made to detect airborne contamination. None was found. Normal cell operations were resumed.

The cost of the supplies utilized in the cleanup was \$912; about \$450 of this sum was for five stainless steel drums for perpetual storage of the curium-contaminated swabs, shoe covers, coveralls, etc. Another \$191 was needed to replace the wire grill over the exhaust duct, electrical extension cords, and dust-stop filters on the ventilation fan outlet. This made a total materials cost of \$1103.

## X. Recommendations

The severity of the release both to personnel and to the facility was increased by the amount of airborne particles released. The most likely cause for this is a puff of contaminated air escaping from the bag, either through a tear or cut. There is no way to absolutely guarantee containment of activity while transferring between contamination and clean zones; however, the bagging techniques developed over years of experience are practical ways to carry this out. Bag sealers have failed to provide adequate seals on occasion. The following considerations would further reduce the probability of large-scale release; however, the probability does not reach zero.

1. Continue to carry out routine bagging operations with the bag sealer or by the tape and cut method.
2. However, where possible, arrange the setup so that the bag is not subject to compression while the sealing and separation are being made; for example, with the bag laying on a table at rest or other similar method.
3. Where possible, provide a relatively clean section of bag for the seal, by protecting a section from contact with the contaminated materials. One way this may be done is to fold an extra length up over the bagout port and pull this down after the bag is loaded.
4. Positive action should be taken to protect the bag from rupture by sharp objects being loaded out. Unfortunately, this will not preclude rupture of the bag by other mechanisms.
5. For the curium cells in 4507, due to the now-established high levels of dusty particles and the diverse nature of the materials to be removed, we feel that personally fitted respirators or masks worn during all bagout operations would serve to preclude the inhalation problems experienced in this spill.
6. Develop a re-training program for the building personnel similar to that used by the Pilot Plant.
7. Obtain an adequate staging area at the penthouse or covered route(s) to the change rooms.

8. Lower the emitted sound power on the nitrogen-operated air horns. We think that two men contaminated their heads holding their hands over their ears to protect themselves from the noise. Perhaps a trumpet mute would work.

Reference

1. Older references are ORNL-CF-65-7-69 and an unnumbered Hazards Review for Curium Processing (October 1964).